PATENT SPECIFICATION

(11) 1 406 143

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(21) Application No. 428/73 (22) Filed 3 Jan. 1973
(31) Convention Application No. 2 200 003 (32) Filed 3 Jan. 1972 in
(33) Germany (DT)
(44) Complete Specification published 17 Sept. 1975
(51) INT. CL.² C23C 17/00
(52) Index at acceptance
C7F 1L 2A 2H 2Z3 2Z8 3D 4A
C7A B249 B25X B25Y B289 B309 B319 B320 B325 B327 B329 B32Y B331 B33X B349 B359 B35Y B361 B363 B365 B367 B369 B36X B389 B399 B419 B420 B422 B42Y B459 B469 B46Y B470 B473 B475 B477 B479 B481 B483 B485 B487 B489 B48X B519 B539 B549 B559 B610 B613 B616 B619 B621 B624 B627 B62X B630 B635 B661 B663 B665 B667 B669 B66X B670

(19)

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(54) A PROCESS FOR THE SURFACE HARDENING OF ALUMINIUM AND ALUMINIUM ALLOY COMPONENTS

(71) We, KARL SCHMIDT G.m.b.H., a body corporate organised under the Laws of Germany, of 8/12 Christian-Schmidt-Strasse, 7107 Neckarsulm, Germany, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a process for the surface hardening of aluminium and aluminium alloy components, and is particularly concerned with but not limited to the surface hardening of aluminium or aluminium alloy pistons for internal combustion engines in the vicinity of the ring zone, preferably in the vicinity of the ring groove at the crown end of the piston.

Internal combustion engines are known which, depending either upon their design or upon the conditions under which they are used, are susceptible to or show particularly high wear of the ring grooves, especially the ring groove at the crown end of the piston, with the danger of breakage of the piston rings. Susceptibility to wear exists when

a) the temperatures in the ring zone are abnormally high on account of the general design of the internal combustion engine,

b) a fuel which forms heavy deposits is used,

c) the piston was designed with considerable play so that it is able to make tilting movements,

d) the filtration of air, especially in a dust-laden environment, for example on building sites, is inadequate and cannot be improved to any appreciable extent.

Piston-ring supports of grey iron or steel have been used in all these cases, being cast with the aluminium or aluminium alloy piston and having the piston-ring grooves machined into them. In this case, the piston-ring is embedded in wear-resistant material and, at the same time, is exposed to lower temperatures.

In many cases, ring supports are also used in order to provide the piston with an extremely long service life. This is advisable in cases where there are equally long intervals between overhauls in the case of all the other important parts of the engine which are also subject to natural wear.

The best previously proposed ring support is a solid ring support which is generally made of a highly alloyed, austenitic cast iron and which has a uniform, solid cross-section, being designed to meet requirements such as the number of piston rings to be accommodated and anchorage in the piston body. On a large scale, the solid ring support is joined to the piston through an intermetallic composite layer produced by the so-called "ALFIN-process" (r. Trade Mark) (Bensinger W. — D. and A. Meier: Kolben, Pleuel und Kurbelwelle bei schnellaufenden Verbrennungsmotoren, 2nd Edition, page 11, Berlin/Göttingen/Heidleberg, 1961).

There is no need to produce an intermetallic composite layer between the ring support and the piston in cases where, instead of the solid ring support, a so-called dissolved ring support is cast into the piston. Since there is no longer any need for a high coefficient of expansion by virtue of its high flexural elasticity, attributable to its meander-like shape, ordinary steel or grey iron can be used as the material for this type of ring support. In operation, the piston-ring is in contact both with the hard flank of the piston-ring and also with the highly heat-conductive piston material.

In another previously proposed aluminium or aluminium alloy piston, the ring grooves formed in the piston are filled with molybdenum, titanium, cobalt, nickel or their alloys, and also with stainless steel in

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a single or multiple layer into which the ring grooves are machined.

By comparison with the prior art discussed above, weight and cost were decisive factors in the development of a process by which it is possible to minimise wear in aluminium and aluminium alloy components, particularly in the vicinity of the ring zone of aluminium and aluminium alloy pistons, in the absence of ring supports of special iron alloys.

According to the present invention there is provided a process for surface hardening an aluminium or an aluminium alloy component, wherein a strength increasing and/or wear resistant alloying material is fused with the component at the surface thereof, such fusion being effected by bombardment of the alloying material and the component by a beam of charged particles, and wherein the surface hardened component is subsequently subjected to a heat treatment which is known *per se*.

This process is particularly applicable where the aluminium or aluminium alloy component is an aluminium or aluminium alloy piston for hardening the piston in the vicinity of the ring zone, particularly in the vicinity of the ring groove at the crown end of the piston.

In carrying out the present process, beams of charged particles such as electron beams or plasma beams may be used.

The aluminium or aluminium alloy is preferably fused with strength increasing and/or wear resistant aluminium based alloy which contains up to 50% by weight of silicon and, optionally, up to 20% by weight of copper.

A particularly preferred alloying material has the composition by weight 14 to 50%, preferably 18 to 30%, of silicon; 1 to 15%, preferably 2 to 6%, of copper; up to 4%, preferably up to 2%, of magnesium and/or up to 10%, preferably up to 5%, of zinc; remainder aluminium and any impurities.

The alloying material may be applied in band or wire form or in the form of a shrunk-on ring in the vicinity of the surface to be hardened.

The surface hardened component is then subjected to a heat treatment which is known *per se*. Such a heat treatment is well known in the art, and may be found, for example, in 'Aluminium-Taschenbach' (Aluminium-Verlag GmbH, Düsseldorf, 1963) p 363, 365.

In some cases, it is advisable for the hardened surface to be treated chemically or mechanically to form a relief consisting of hard constituents, preferably silicon.

The surface obtained by the present process has a much higher silicon content than the aluminium or aluminium alloy, the silicon being in extremely fine distribution, and a higher content than the aluminium or aluminium alloy of elements which harden the aluminium mixed crystal.

These properties increase resistance to wear, the red hardness and high temperature stability of the area of the aluminium or aluminium alloy, especially the piston material, treated by the present process, to such a considerable extent that the wearing effect and also the deforming effect for example of the piston-rings in the ring grooves encounters a resistance comparable with the ring support. In addition to this, there are no welding-induced residual stresses which avoids brittle fractures.

By suitably selecting the quantity of alloying material and the depth of the fusion zone, it is possible to vary the depth of surface hardening within wide limits.

WHAT WE CLAIM IS:—

1. A process for surface hardening an aluminium or an aluminium alloy component, wherein a strength-increasing and/or wear-resistant alloying material is fused with the component at the surface thereof; such fusion being effected by bombardment of the alloying material and the component by a beam of charged particles and wherein the surface hardened component is subsequently subjected to a heat treatment which is known *per se*.

2. A process as claimed in Claim 1, wherein the alloying material is an aluminium based alloy, which contains up to 50% by weight of silicon and, optionally, up to 20% by weight of copper.

3. A process as claimed in Claim 1 or 2, wherein the alloying material has the composition by weight 14 to 50% of silicon, 1 to 15% of copper, up to 4% of magnesium and/or up to 10% of zinc, remainder aluminium and any impurities.

4. A process as claimed in any one of Claims 1 to 3, wherein the alloying material has the composition by weight 18 to 30% of silicon, 2 to 6% of copper, up to 2% of magnesium and/or up to 5% of zinc, remainder aluminium and any impurities.

5. A process as claimed in any one of Claims 1 to 4, wherein the alloying material to be fused is applied in band or wire form in the vicinity of the surface to be hardened.

6. A process as claimed in any one of Claims 1 to 4, wherein the alloying material to be fused is shrunk-on in the form of a ring in the vicinity of the surface to be hardened.

7. A process as claimed in any one of Claims 1 to 5, wherein the hard constituents, preferably the silicon, are brought out in relief form in the vicinity of the hardened surface by a chemical and/or mechanical treatment.

8. A process for surface hardening a light metal component in accordance with Claim 1 substantially as hereinbefore described.

9. A light metal piston for an internal combustion engine, wherein the piston has been surface hardened in the vicinity of the ring zone by the process claimed in any preceding claim.

10. A piston as claimed in Claim 9, wherein the piston has been surface hardened in the vicinity of the ring groove at the crown end of the piston.

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Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1975.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.